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First record of larvae of the rare mud shrimp *Naushonia* Kingsley (Crustacea: Decapoda: Laomediidae) from Asian waters

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Abstract.—Larvae of an undetermined species of the laomediid genus *Naushonia* Kingsley are reported from plankton samples collected in Gokasho Bay, Pacific coast of Japan. The presence of stage 1 zoeas suggests that adult shrimps of *Naushonia* are distributed in the neighboring district. This is the first record of *Naushonia* from Asian waters.

The rare laomediid genus *Naushonia* Kingsley, 1897 consists of seven species, none of which are known from Asian waters (Martin & Abele 1982, Berggren 1992, Alvarez et al. 2000). There is scant larval information on these rare mud shrimps to date, although all known species of *Naushonia* occur in very shallow benthic waters. Since Thompson's (1903) work, planktonic larval stages of *Naushonia* species have been described for *N. crangonoides* Kingsley, 1897, *N. portoricensis* (Rathbun, 1901) and two undetermined species (Gurney & Lebour 1939, Dakin & Colefax 1940, Kurian 1956, Goy & Provenzano 1978).

During plankton collections made at Gokasho Bay, Japan, in the summer of 2000, zoea 1 larvae belonging to an undetermined species of *Naushonia* were found. These zoeas are described in this study, representing the first record of the genus in Asian waters.

Materials and Methods

The zoea 1 larvae were taken in a 300 μm mesh and 46 cm diameter tow-net, at depths of 5–10 m, at Gokasho Bay, Mie Prefecture, Japan, 34°20′N, 136°42′E, on 27 Jul, 2 and 10 Aug 2000. Water temperature and salinity of the collection sites ranged from 25 to 27°C and 33.5 to 33.7‰ respectively.

Living specimens were observed and sorted under a Nikon SMZ-10 stereomicroscope. After fixation in 3% buffered formalin, the appendages were dissected with fine insect pins or sharpened tungsten needles under the stereomicroscope, and mounted on a silicon-coated glass slide. Drawings and measurements were made with a drawing tube attached to an Olympus BH-2 microscope. A color image of a living specimen was captured with an Olympus HC-300/OL digital camera connected to the microscope. All illustrations were made with Illustrator™ 5.5J (Adobe Systems Inc.) on a Mactintosh™ OS (Apple Co. Ltd.). Carapace length (CL) was measured from the tip of the rostral spine to the medial posterior border of the carapace.

Voucher specimens have been deposited in the Natural History Museum and Institute, Chiba, Japan, under accession numbers CBM-ZC 5573-5575.

Description of zoea 1

Size: CL = 0.73 ± 0.036 mm (range 0.70–0.77 mm, 3 specimens).

Color (Fig. 1): Small red and large yellowish chromatophores dispersed on antennule, and mainly ventral side of carapace and abdomen.

Carapace (Fig. 2A, B): Rostral spine short, slender, upturned distally. Posterolateral border rounded. Eyes sessile.

Fig. 1. Photograph of a living specimen of zoea I of *Naushonia* sp. Note chromatophores on ventral side. Scale = 0.1 mm.

Antennule (Fig. 3A): Uniramous, about half-length of CL, unsegmented with 5 aesthetascs terminally, and long plumose seta subterminally.

Antenna (Fig. 3B): Biramous. Protopod with simple spine at base of exopod. Endopod with 3 long plumose setae distally. Exopod (=antennal scale) flat, elongated, oval, with 10 plumose setae on inner margin.

Mandibles (Fig. 3C): Asymmetrical. Left with incisor process large, sickle-shaped, with 2 subterminal inner spines; right small, conical, with subterminal inner spine. Right and left molar processes almost equal in size, but different in dentation. Paragnath of left side (Fig. 3C′) slender sickle-shape as in left mandible.

Maxillule (Fig. 3D): Coxal endite with 4 simple setae and subterminal small seta. Basial endite with 2 large teeth and 2 simple setae. Endopod unsegmented with 3 terminal setae.

Maxilla (Fig. 3E): Coxal endite bilobed, proximal lobe small, with 1 long and 1 short plumose setae, and distal lobe with simple 3 setae. Basial endite bilobed with 5+4 simple setae, respectively. Scaphognathite without proximal lobe, and with 5 plumose setae on margin.

Maxilliped 1 (Fig. 3F): Biramous. Coxa without setae. Basis with 1+2+3 inner setae. Endopod 4-segmented with 2,1,2,5+I (I = dorsal seta) seta. Exopod with 4 natatory plumose setae terminally, symmetrically arrangement in 2 tiers (Fig. 3F′).

Maxilliped 2 (Fig. 3G): Biramous. Coxa and basis with no setae. Endopod 4-segmented with 0,0,2,4+I setae. Exopod as in maxilliped 1.

Maxilliped 3 (Fig. 3H): Uniramous, 3-segmented, without setae.

Pereiopods: Rudimentary.

Abdomen (Fig. 2A): Smooth, 5 somites plus forked triangular telson. Abdominal somite 1 with short rod-like pleural projection (Fig. 2A′) and somite 2-5 with anteriorly procurved pleural hooks.

Telson (Fig. 2C, C′): Triangular, with deep notch and 7 pairs of posterior processes; outermost process stout, unarticulated spine; second process thin plumose seta (=anomuran hair) on ventral side of telsonal fork (Fig. 2C′); third through seventh processes large articulated plumose setae.

Discussion

The infraorder Thalassinidea consists of 11 families (Poore 1994) and larval stages

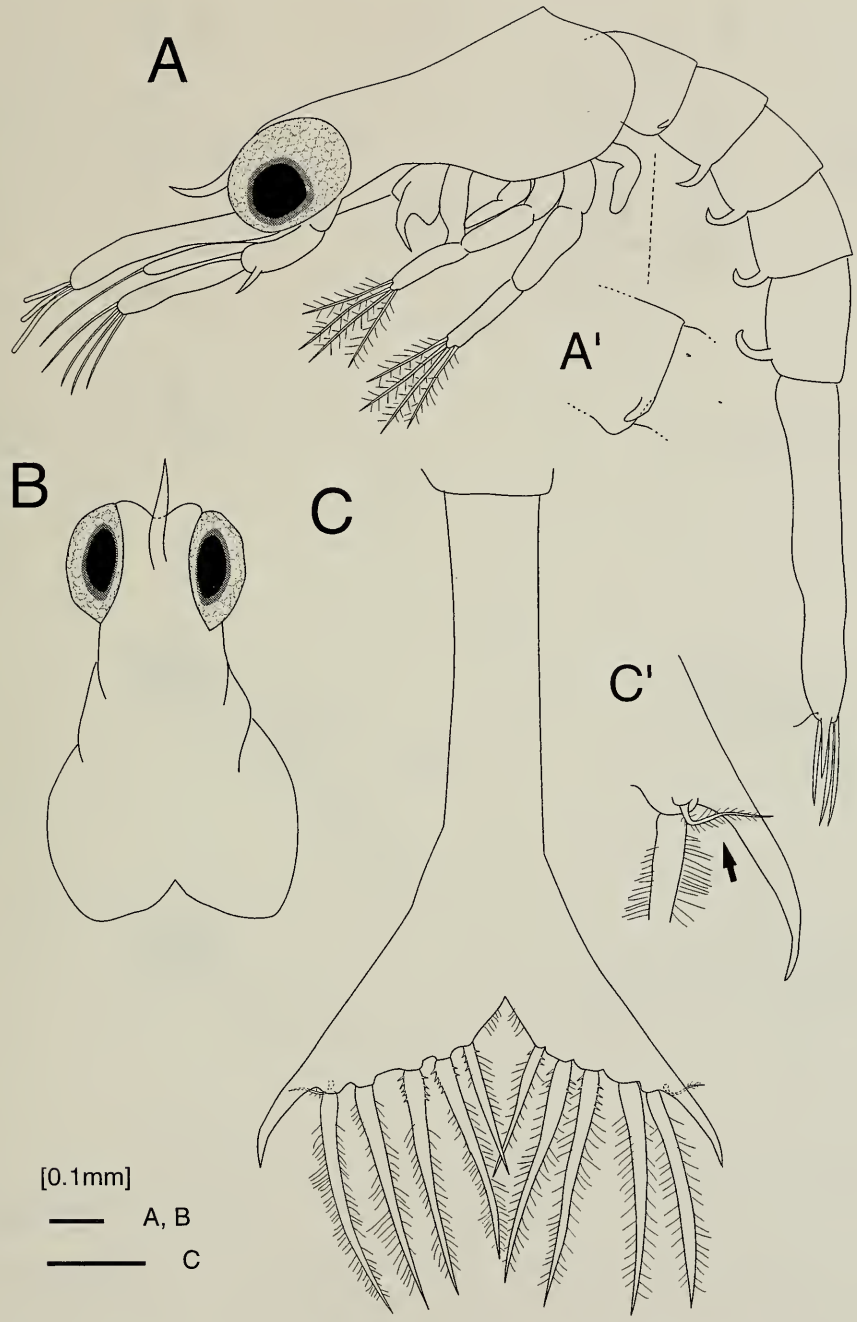

Fig. 2. *Naushonia* sp., zoea 1. A, whole animal, lateral view; A′, enlarged posterior part of abdominal somite 1; B, carapace, dorsal view; C, telson, dorsal view; C′, enlarged right telsonal fork, ventral view, showing 'anomuran hair' (arrow).

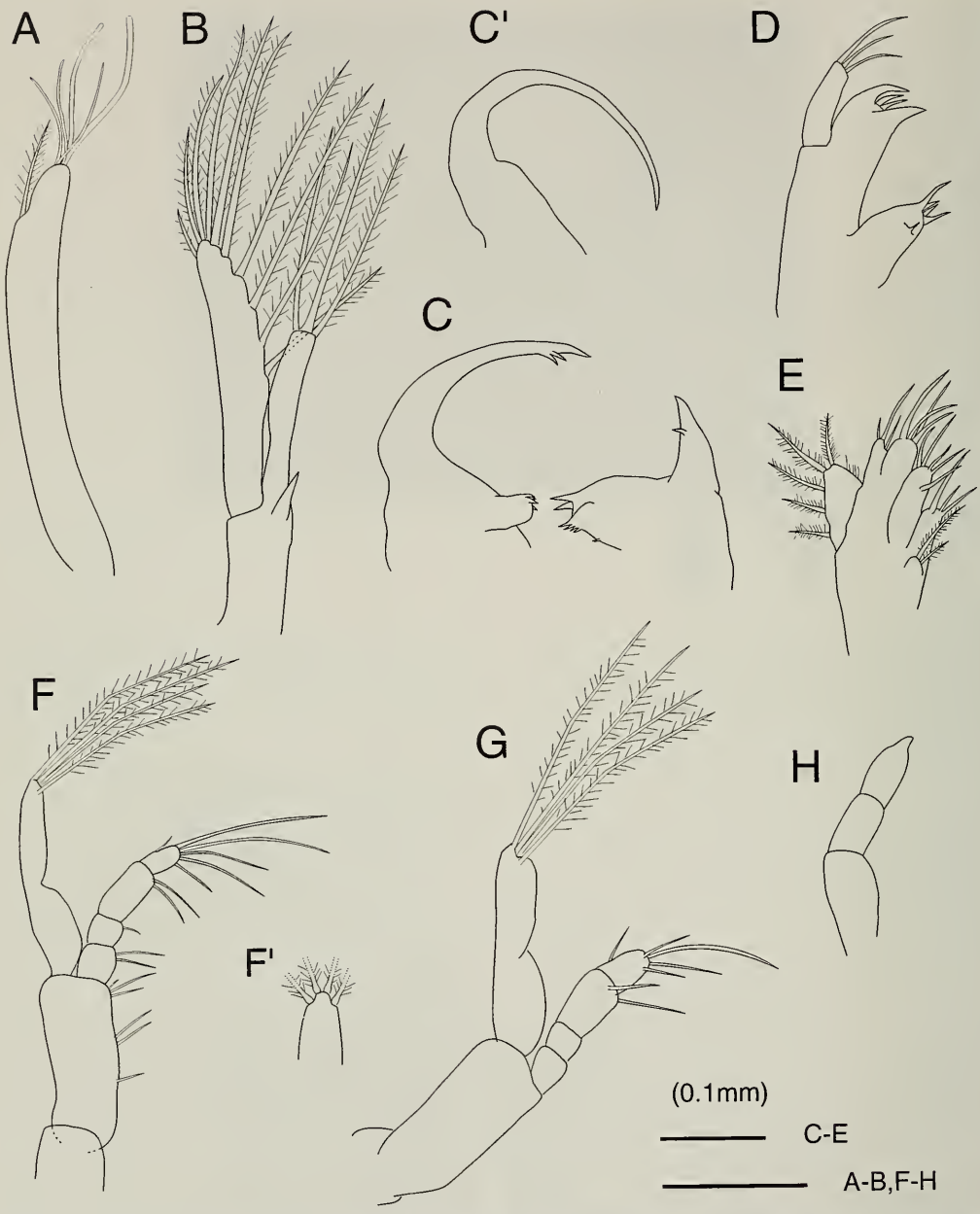

Fig. 3. *Naushonia* sp., zoea 1. A, antennule; B, antenna; C, mandibles; C′, left paragnath lobe; D, maxillule; E, maxilla; F, maxilliped 1; F′, tip of exopod of maxilliped 1; G, maxilliped 2; H, maxilliped 3.

have been described for species in six families. Laomediid zoeal larvae differ from those of other decapod shrimps by the considerably asymmetrical mandibles and procurved pleural hooks on the abdominal somites (see Konishi 1989). A recent study of *Thalassina anomala* (Herbst, 1804) of the Thalassinidae Latreille, 1831, has revealed that its zoea also has a sickle-shaped asymmetrical pair of mandibles as in the Laomediidae Borradaile, 1903 (Uchino 1993). Zoeas of *T. anomala,* however, have a

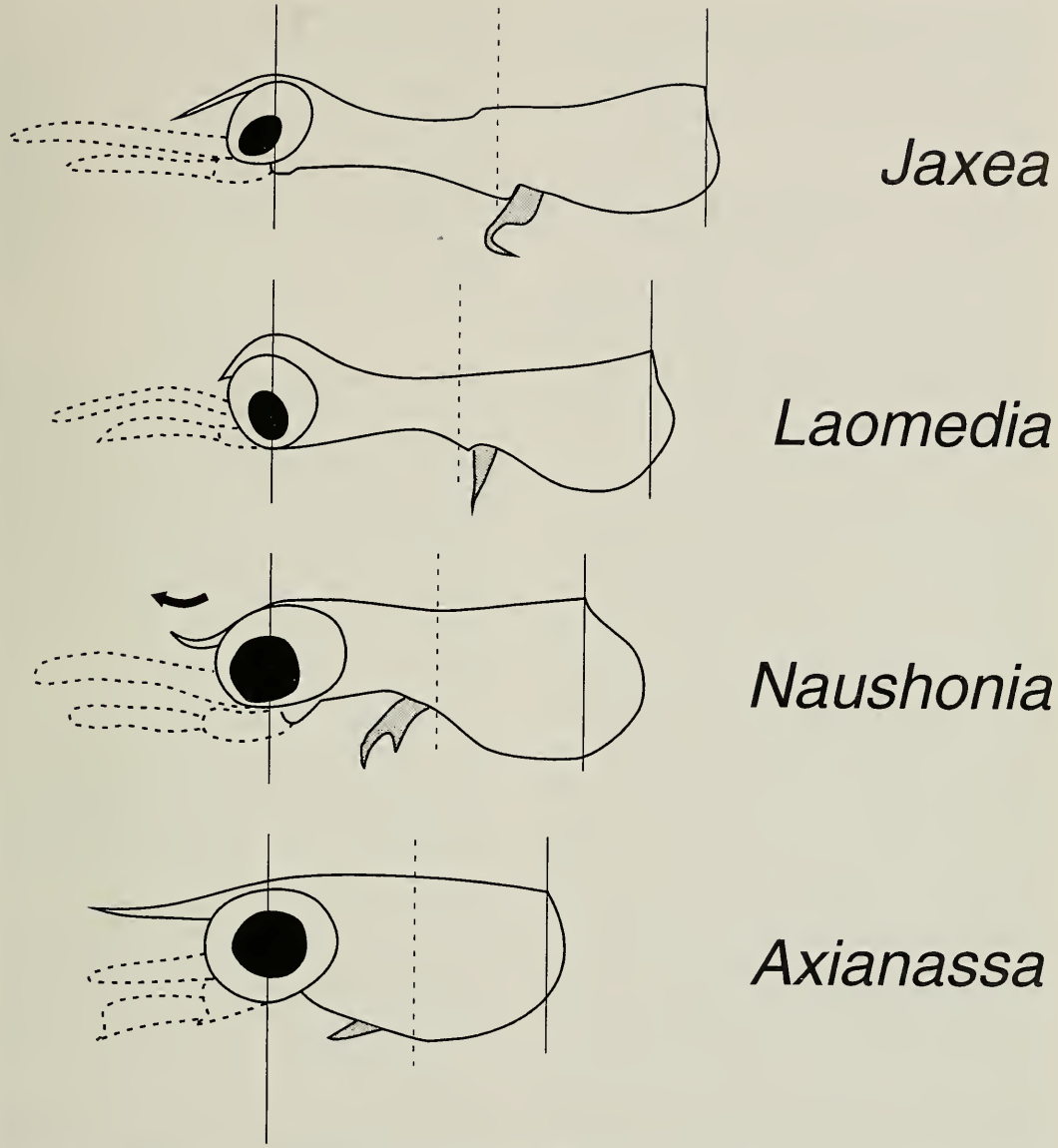

Fig. 4. Diagrammatic representation of zoeal cephalothoraxes in four laomediid genera showing relative position of mandible (shaded). Vertical dotted line indicates midpoint of carapace length. (Based on Gurney 1924; Ngoc-Ho 1981; Fukuda 1982).

unique larval character: i.e., the extremely elongated endopod of maxilliped 2. Thus, the laomediid zoeas can be easily separated from the Thalassinidae despite similarities in the mandibles.

The Laomediidae includes 5 genera as follows (Ngoc-Ho 1981): *Laomedia* De Haan, 1841, *Naushonia, Jaxea* Nardo, 1847, *Axianassa* Schmitt, 1924, and *Lauretiella* Le Loeuff & Intes, 1974. Larval stages are known for representative species in all of them except *Lauretiella* (Thompson 1903, Caroli 1924, Gurney 1924, Gurney & Lebour 1939, Dakin & Colefax 1940, Kurian 1956, Sakai & Miyake 1964, Goy & Provenzano 1978, Ngoc-Ho 1981,

Fukuda 1982, Rodrigues & Shimizu 1992). Their zoeas are clearly distinguishable between genera. The mandibles of *Naushonia* and *Axianassa* are located anterior to the mid point of the carapace as in typical decapod zoeas, while those of *Jaxea* and *Laomedia* are posterior (Fig. 4). The rostrum of *Naushonia* is short and upturned whereas it is long and straight in *Axianassa.* In addition, the abdomen of *Axianassa* zoea bear a pair of posterolateral spines on somite 5 instead of procurved pleural hooks on somite 2-5 as found in *Jaxea, Naushonia* and *Laomedia.* Therefore, zoeas of *Naushonia* species are easily identified.

The morphology of the herein reported Japanese zoeas is different from those of *N. crangonoides* and *N. portoricensis* described by Goy & Provenzano 1978 and Gurney & Lebour 1939, in antennule, maxillule and pleural projection on abdominal somite 1. The antennule, has two subterminal plumose seta in *N. crangonoides,* whereas only one in the present zoea. The coxal endite of maxillule bears a small proximal lobe in the present zoea, whereas there is no lobe in the zoea of others. The present zoeal specimens, therefore, seems to belong to a species different from those for which larvae are known, or perhaps to an unknown species of the genus.

Until now, the Laomediidae was represented in Japan by only one genus *Laomedia* (Miyake, 1998). The present zoeas, however, are clearly assignable to *Naushonia* species. According to findings for rearing of plankton-caught zoeas of *N. crangonoides* by Goy & Provenzano (1978), zoea 1 molt to the next instar within 5.24 days in average when they were incubated at 25°C. This strongly suggests that adult shrimps of *Naushonia* must be distributed in the neighboring district of Gokasho Bay in Japan or very nearby waters.

There may be two reasons why *Naushonia* larvae have not been reported previously from Japan and adjacent waters. First, they may be of very rare species (Berggren 1992) in Japan and adjacent Asian waters. Second, *Naushonia* does not have native representative, and the present zoeas are from recent introduction of an exotic species, as has occurred with the Mediterranean portunid crab in Tokyo Bay, Japan (Sakai 1986). A careful faunal survey, and further larval studies of the coast of Japan, may be needed to answer this question.

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